THE ANIMAL MODEL IN SOUTH AFRICA

GJ Delport[1], LFB Loubser, L Rautenbach and GJ Erasmus,[2]

[1] ADSRI, Irene, South Africa, [2] Univ Orange Free State, Bloemfontein, South Africa.

Introduction

After introduction of mixed model procedures by means of a sire model in 1987, the South African dairy industry changed to routine breeding value evaluation by means of animal model analysis in 1992.

The South African dairy population is heavily dependent on imported sires. Only 36 % of bulls with local sires were accepted as potential AI sires in the Holstein-Friesian breed (Theron et al, 1992). The industry is also characterised by a comparatively low average production level (5 528 kg/lactation) and diverse production systems. Preferential treatment of cows mated to imported bulls as well as heterogeneous variance may therefore be of importance in evaluation procedures. In fact industry has this far stuck to univariate analysis of first lactation records in order to avoid the even larger potential bias of later lactations.

In this paper a preliminary investigation into the existence of Sire x Herd interaction and heterogeneous variance in the three breeds of secondary importance (Jersey, Ayrshire and Guernsey) is reported. Mention is also made of procedures used for analysis of type traits.

Material and methods

The current data set of first lactation records (Table 1) dates back to 1978. Apart from normal editing procedures all bulls with progeny in only one herd were filtered out in order to facilitate evaluation of Herd x Sire interaction (H x S).

Table 1: Data set used for breeding value evaluation of the Jersey, Ayrshire and Guernsey breeds in South Africa.

Breed	Milk prod (kg)		Butterfat (kg)		Protein (kg)		
	Mean	Sd	Mean	Sd	Mean	Sd	n
Jersey	3593.9	965.8	161.6	43.9	134.9	36.3	40906
Ayrshire	4310.7	1222.4	162.5	45.7	147.9	42.4	8567
Guernsey	3747.2	969.2	159.0	42.1	131.6	34.7	4698

In a first step to establish the possible presence of H x S interaction and preferential treatment all data sets were standardized and correlations between contemporary group means and standard deviations estimated.

The following operational model (Model 1, also used for routine evaluation purposes) was used for variance component estimation:

$$y_{ijk} = \mu + h_i + c_j + a_k + e_{ijk}$$

Where :

y_{ijk} = Observation on the k'th animal in the i'th herd year and j'th age class,

h_i = effect of the i'th herd year,

c_j = effect of the j'th age class (6 classes),

a_k = random effect of the k'th animal,

e_{ijk} = random error.

The second model (Model 2) including H x S interaction was as follows:

$$y_{ijkl} = \mu + h_i + c_j + a_k + s_l + e_{ijkl}$$

Where :

y_{ijkl} = Observation on the k'th animal in the i'th herd year and j'th age class,

h_i = effect of the i'th herd year,

c_j = effect of the j'th age class (6 classes),

a_k = random effect of the k'th animal,

s_l = random effect of herd x sire interaction,

e_{ijkl} = random error.

Variance components were estimated using DFREML (Meyer, 1991) and results from the two models above were used to investigate the usefulness of the second model for routine analysis.

Results and discussion

Correlations between means and standard deviations is presented in Table 2.

Table 2 : Correlations of standard deviation per contemporary group mean and herd size.

Breed	Milk		Butterfat		Protein	
	Cg Mean	Cg Size	Cg Mean	Cg Size	Cg Mean	Cg Size
Jersey	0.436	0.214	0.409	0.204	0.430	0.215
Ayrshire	0.341	0.248	0.388	0.218	0.350	0.238
Guernsey	0.504	0.082	0.462	0.031	0.486	0.047

Although more sophisticated methods to adjust for heterogeneous variances are available (Wiggans et al, 1991; Weigel et al, 1993 and Powell et al, 1994), the results in Table 2 serve as a preliminary indication of the possibility of preferential treatment and possibly heterogeneous variance in at least the Jersey and Ayrshire breeds.

Results in Table 3 indicate overestimation of heritability estimates when ignoring H x S interaction (Tassell et al, 1994). Table 3 also indicates substantial interaction variance in the Jersey compared to the Ayrshire and Guernsey. Standardisation of the data sets and inclusion of H x S interaction also accounts for the same sources of variation (Table 3). However better theoretical justification exists for applying Model 2.

Table 4 indicates a substantial reduction in error variance by applying Model 2 to the Jersey breed. It is clear from tables 3 and 4 that in the words of Tässel et al 1994 " These biases indicate that interaction should be included in the variance component model even if the data only moderately unbalanced and H x S is expected to be present at relatively low levels".

The effect of four different statistical strategies on breeding value evaluation is indicated by rank correlation coefficients between the respective sets of breeding values for milk production in the Jersey population (Table 5). Results in Table 5 indicate more changes in the ranking of privately owned bulls, less with regard to Imported bulls and the cow population and least with regard to local AI bulls. These correlations conform to the logical expectation that the data for privately owned

Table 3 : Heritability estimates of production traits obtained by two models ignoring and including H x S interaction.

breed	Model	Trait		
		Milk	Butterfat	Protein
Jersey	1 Orig	0.332	0.334	0.306
	Std	0.280	0.244	0.256
	2 Orig	0.269	0.249	0.234
	C_2	0.136	0.163	0.159
	Std	0.278	0.243	0.254
	C_2	0.003	0.005	0.005
Ayrshire	1 Orig	0.366	0.341	0.337
	Std	0.367	0.325	0.333
	2 Orig	0.339	0.311	0.308
	C_2	0.034	0.045	0.041
	Std	0.350	0.304	0.313
	C_2	0.027	0.038	0.033
Guernsey	1 Orig	0.366	0.280	0.297
	Std	0.312	0.209	0.233
	2 Orig	0.345	0.257	0.263
	C_2	0.037	0.043	0.050
	Std	0.295	0.195	0.206
	C_2	0.025	0.018	0.033

* Orig = Data on original scale
Std = Standardized data

Table 4: Residual and error variance expressed as a percentage of the total phenotypic variance on the original and standardized scale obtained by two models ignoring and including HxS interaction.

breed	Model		Trait		
			Milk	Butterfat	Protein
Jersey	1	Orig	66.85	66.65	69.36
		Std	77.06	75.56	74.45
	2	Orig	59.56	58.76	60.79
		Std	71.89	75.25	74.13
Ayrshire	1	Orig	63.45	65.94	66.27
		Std	63.26	67.46	66.73
	2	Orig	62.67	65.89	65.04
		Std	62.30	64.42	65.48
Guernsey	1	Orig	63.40	72.04	70.29
		Std	68.76	79.13	76.70
	2	Orig	61.85	69.99	68.72
		Std	67.98	48.01	76.12

* Orig = Data on original scale
Std = Standardized data

Table 5: Spearman rank correlation coefficients between breeding value estimations obtained by four strategies for milk production of the South African Jersey population.

SEX	ORIGIN	n		MODEL		
				1 Std	2 Orig	2 Std
Bulls	Imported	108	1 Orig	0.880	0.963	0.880
			1 Std		0.870	1.000
			2 Orig			0.873
Bulls	Local AI	128	1 Orig	0.911	0.963	0.910
			1 Std		0.929	1.000
			2 Orig			0.930
Bulls	Private	781	1 Orig	0.714	0.935	0.714
			1 Std		0.751	1.000
			2 Orig			0.754
Cow	Total	40906	1 Orig	0.863	0.969	0.863
			1 Std		0.887	1.000
			2 Orig			0.889

bulls may be more unbalanced and that imported bulls and the cow population may be more subject to preferential treatment and H x S interaction.

Other developments

A Multiple trait model to evaluate type traits was implemented during 1993 by the SA Holstein Friesland Society. The model makes provision for 5 fixed effects (herd, year, month, classifier, age at inspection) and 1 random animal effect. The current data set consists of 79 256 records for 15 type traits.

Conclusions

Data sets in South Africa are relatively small (218 586 first lactation records for Holstein Frieslands) and the principle of inclusion of more lactations is not yet well accepted. In this situation the inclusion of H x S interaction in univariate animal models for routine breeding value evaluation might be useful. The model including H x S interaction also provides additional information for evaluation purposes.

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